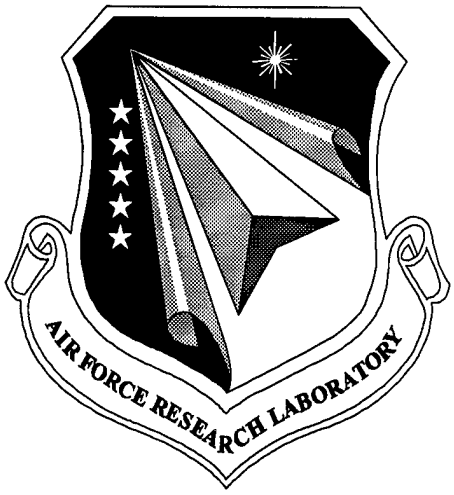
AFRL-ML-WP-TM-1998-4060

# MECHANISMS OF THIN FILM GROWTH AND THE INFLUENCE OF SURFACE CHEMISTRY ON FILM GROWTH AND PROPERTIES

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APRIL 1998

FINAL REPORT FOR 10/01/1990 - 09/30/1997

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# REPORT DOCUMENTATION PAGE

*Form Approved*
*OMB No. 0704-0188*



| 1. AGENCY USE ONLY *(Leave blank)* | 2. REPORT DATE | 3. REPORT TYPE AND DATES COVERED |
|---|---|---|
| | APR 1998 | FINAL 10/01/1990--09/30/1997 |

**4. TITLE AND SUBTITLE** MECHANISMS OF THIN FILM GROWTH AND THE INFLUENCE OF SURFACE CHEMISTRY ON FILM GROWTH AND PROPERTIES

**5. FUNDING NUMBERS**
C
PE 61102
PR 2303
TA BW
WU 0P

**6. AUTHOR(S)** WILLIAM V. LAMPERT
T.W. HAAS

**7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES)**
MATERIALS AND MANUFACTURING DIRECTORATE
AIR FORCE RESEARCH LABORATORY
AIR FORCE MATERIEL COMMAND
WRIGHT PATTERSON AFB OH 45433-7734

**8. PERFORMING ORGANIZATION REPORT NUMBER**

**9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)**
MATERIALS AND MANUFACTURING DIRECTORATE
AIR FORCE RESEARCH LABORATORY
AIR FORCE MATERIEL COMMAND
WRIGHT PATTERSON AFB OH 45433-7734
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**10. SPONSORING/MONITORING AGENCY REPORT NUMBER**
AFRL-ML-WP-TM-1998-4060

**11. SUPPLEMENTARY NOTES**

**12a. DISTRIBUTION/AVAILABILITY STATEMENT**
APPROVED FOR PUBLIC RELEASE; DISTRIBUTION IS UNLIMITED.

**12b. DISTRIBUTION CODE**

**13. ABSTRACT** *(Maximum 200 words)*

THIS PROGRAM WAS A FUNDAMENTAL RESEARCH STUDY OF THE MECHANISMS OF THIN FILM GROWTH AND THE INFLUENCE OF SURFACE CHEMISTRY ON FILM GROWTH AND PROPERTIES. THE FILM GROWTH TECHNIQUES BEING EMPHASIZED INCLUDE PULSE LASER DEPOSITION AND MOLECULAR BEAM EPITAXY. THIS IS A BIBLIOGRAPHY OF THE PUBLICATIONS GENERATED BY THIS PROGRAM.

**14. SUBJECT TERMS**
THIN FILM GROWTH, PULSE LASER DEPOSITION, MOLECULAR BEAM EPITAXY, CHEMICAL BEAM EPITAXY, CARBON FILMS, GAAS, TUNGSTEN THIN FILMS

**15. NUMBER OF PAGES**
23

**16. PRICE CODE**

| 17. SECURITY CLASSIFICATION OF REPORT | 18. SECURITY CLASSIFICATION OF THIS PAGE | 19. SECURITY CLASSIFICATION OF ABSTRACT | 20. LIMITATION OF ABSTRACT |
|---|---|---|---|
| UNCLASSIFIED | UNCLASSIFIED | UNCLASSIFIED | SAR |

**Approach:** Pulse laser deposition will be used to deposit SiC films on SiC substrates at various substrate temperatures and deposition rates homoepitaxial growth will be monitored in-situ with electron diffraction and ex-situ by x-ray diffraction. Stoichiometry will be adjusted through the use of an SI beam source. In nanometric processing of epitaxial materials work, a diamond micromachine apparatus will be used to pattern GaAs substrates prior to epitaxial film growth in an MBE system. Finally, epitaxial films grown by MBE will be transferred through a UHV transfer system to a multi-technique surface analysis system where surface chemistry will be defined and correlated with growth parameters, surface crystallography as determine by RHEED and subsequently correlated with electronic and optical materials properties.

The **objective** of this program is a fundamental research study of the mechanisms of thin film growth and the influence of surface chemistry on film growth and properties. Film growth techniques being emphasized, include pulse laser deposition and molecular beam epitaxy. Specific current topics include determinations of the surface and near surface chemistry and morphologies of diamond turned substrates and the properties and behavior of these substrates for thin film growth. The interface chemistries of MBE grown materials are being investigated by a variety of surface analysis techniques and are being correlated with electronic and electrooptic properties of semi-conductive epitaxial films in order to lead to improved device materials. ISS is particularly valuable because of its top atomic layer sensitivity. Fundamental properties of pulse laser deposition with particular emphasis on possibilities for epitaxial film growth of SiC for high temperature electronic applications are also under investigation, as well as optical sensors to monitor films growth. In the nanometric processing of epitaxial materials area we are investigating the surface chemistry of diamond turned substrates. Of particular interest is the use of diamond patterning to prepare substrates for thin film growth. This research, if successful, could lead to revolutionary new means for growth of quantum wires and quantum dots for a variety of electro-optic and possible magnetic materials applications.

Attached is a bibliographic listing of publications associated with this work.

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"A Lattice Engineered Compliant Universal (CU) Substrate Using a (Twist-) Wafer Bonding technology," F.E. Ejeckam, M.L. Seaford, Y.H. Lo, H.Q. Hou, and B.E. Hammons, Proceedings of the 1996 Lasers and Electro-Optic Society, Nov. 1996.

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"Morphology and Microstructure of Epitaxial Cu(001) Films Grown by Primary Ion Deposition on Si and Ge Substrates," B.W. Karr, Y.W. Kim, I. Petrov, D.B. Bergstrom, D.G. Cahill, and J.E. Greene, Journal of Applied Physics (in press).

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"Tensile Strain Relaxation in GaNxP1-x (X-less than or equal to 0.1) Grown by Chemical Beam Epitaxy", N.Y. Li, W.S. Wong, D. H. Tomich, K. L. Kavanagh, J. Vac. Sci. Tech B., Vol. 14 (4) pp 2952-2956.

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"Study of Strain Relaxation in $GaN_xP_{1-X}$ (x<10.2%) on GaP grown by Chemical Beam Epitaxy," N.Y. Li, W.S. Wong, D.H. Tomich, K.L. Kavanagh, and C.W. Tu, W.S. Wong, (submitted to J. Vac. Sci. Technol.).

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"Neural-net Based Optical Ellipsometry for Monitoring Growth of Semiconductor Films", G. H. Park, Y. H. Pao, K. G. Eyink, and M. S. Socloff submitted for publication.

"Metallurgy of Al-Ge-Ni Ohmic Contact Formation on n-GaAs," X. Y. Lin, W. V. Lampert, T. W. Haas, P. H. Holloway, W. Swider, Z. Liliental-Weber and J. Washburn Submitted to J. Vac. Sci. Technol. B.

"Characterization of chitosan and rare-earth-metal-ion doped chitosan films," Hao Jiang, Jim Lang, John T. Grant, Weijie Su, Thomas M. Cooper, W. Wade Adams, Submitted to Macromol. Chem. Phys.

## Invited Lectures And Presentations At Technical Symposia:

"Overview of WUD 50:Surface and Interface Properties," W. V. Lampert, AeroMat '96 7th Annual Advanced Materials and Processes Conferences, Dayton Convention Center, Dayton Ohio, 5 July 1996.

"Arsenic Free GaAs Substrate Preparation Studied by Atomic Force Microscopy," D. H. Tomich, N. Y. Li, A. Y. Lew, and C. W. Tu. Poster presented at the 23rd Conference on the Physics and Chemistry of Semiconductor Interfaces, La Jolla, CA, January, 1996.

"GaAs(001) & (111)B Substrate Preparation studied by Atomic Force Microscopy," D. H. Tomich, NoYo Li, and C. W. Tu, 1996 Electronic Materials Conference, Santa Barbara, CA June 1996.

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"The Application of Multiphoton Ionization to Analyze the Plume Dynamics from Laser-Ablated 6H-Silicon Carbide," M. A. Capano accepted by the Journal of Applied Physics.

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**Invention Disclosures**

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"FORMATION OF $C_3N_4$ CLUSTERS BY LASER ABLATION OF NITRIDED GRAPHITE," P. T. Murray and M. Y. Chen, Submitted to Surface Review and Letters.

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## Articles Submitted for Publication

"INVESTIGATION OF THE Al-Ge-Ni ALLOY SYSTEM USED FOR HIGHER TEMPERATURE OHMIC CONTACTS TO GAAS", W. V. Lampert, T. W. Haas, and Paul H. Holloway, Submitted to Thin Solid Films

"MASS AND SPEED DISTRIBUTIONS OF NEUTRAL AND POSITIVELY-CHARGED SPECIES EJECTED FROM LASER-ABLATED 6H-SiC", M. A. Capano, Submitted to Journal of Applied Physics.

"OPTICAL ABSORPTION OF MOLECULAR BEAM EPITAXIAL GaSb GROWN ON SEMI-INSULATING GaAs SUBSTRATE", M. O. Manasreh R. Kaspi, S. Mayan, P. Yu, and M. Y. Yen, submitted to Appl. Phys. Lett.

"PHOTOLUMINESCENCE OF Mg-Ion IMPLANTATION IN LOW TEMPERATURE GROWN GaAs" P.W. Yu, M. Y. Yen, C. E. Stutz, and K. R. Evans, submitted to Appl. Phys.

"A PARAMETRIC STUDY OF PULSED LASER DEPOSITED NIOBIUM DISELENIDE THIN FILM GROWTH", A.E. Day and J.S. Zabinski, submitted to Thin Solid Films.

"PULSED LASER DEPOSITION OF CARBON FILMS: DEPENDENCE OF FILM PROPERTIES ON LASER WAVELENGTH", P.T. Murray and D.T. Peeler, J. Electron. Mater, To be published.

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"THE USE OF RAMAN SCATTERING TO STUDY DISORDER IN PULSED LASER DEPOSITED FILMS", N.T. McDevitt, J.S. Zabinski, and M.S. Donley, submitted to Thin Solid Films.

"PULSED LASER INTERACTIONS WITH GRAPHITE", P.T. Murray and D.T. Peeler, 2nd International Conference on Laser Ablation, Knoxville, TN. Lecture Notes in Physics (Springer -Verlag) P.T. Murray and D.T. Peeler, submitted.

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"DEGRADATION OF A BRANCHED PERFLUOROPOLYALKYLETHER FLUID WITH ANHYDROUS ALUMINUM CHLORIDE", K.C. Eapen, P.J. John, and J. Liang, submitted to Die Makromoleculare Chemie, August 1993.

**Invention Disclosures**

METHOD FOR FORMING THIN SOLID LUBRICIOUS FILMS AND FILM ARTICLES MADE THEREBY, Inventors: Michael S. Donley, Paul T. Murray, and Trice W. Haas, Patent Number: 5,002,798, Date: 26 Mar 1991; reissued 1992.

**Invited Lectures, Presentations, and Talks**

"PROPERTIES OF C-N THIN FILMS GROWN BY REACTIVE MAGNETRON SPUTTERING", M.Y. Chen, Y. W. Chung, M.S. Wong, and W. D. Sproul, Am.Vac. Soc. Fall Meeting, Nov 1992.

"INVESTIGATION OF THE Al-Ge-Ni ALLOY SYSTEM USED FOR HIGHER TEMPERATURE OHMIC CONTACTS TO GAAS", W. V. Lampert, T. W. Haas, and Paul H. Holloway, Presented at 1993 ICMCTF Meeting.

"THE EFFECTS OF INTERFACIAL REACTIONS IN THE FORMATION OF OHMIC CONTACTS TO GaAs", Verlyn Fischer, P. H. Holloway, P. Viljoen, and E. Ristolainen, W. V. Lampert, T. W. Haas, and J. M. Woodall, Presented at spring 1993 MRS Meeting, April 1993.

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"AES AND XPS STUDIES OF OXYGEN ION SPUTTERED GaAs SURFACES", 15th Symposium on Applied Surface Analysis, Cleveland; June 1993. J. S. Solomon, and J. T. Grant.

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"REAL TIME HEAT TREATMENT AND I-V MEASUREMENT OF AL-GE- NI OHMIC CONTACTS ON (100) GaAs: EFFECTS OF GROWTH SEQUENCE", W. V. Lampert, T. W. Haas, and P. H. Holloway, Presented to 22nd Annual Symposium on Applied Vacuum Science and Technology, February, 1993.

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MODELING OF MBE GROWTH WITH INTERACTING FLUXES: D.H. Tomich, T.W. Haas, M.A. Capano, R. Kaspi, W.T. Cooley ,Spring MRS Meeting, San Francisco, CA, 14 Apr 93.

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"TRIBOMATERIALS AND LASER PROCESSING FOR EXTREME ENVIRONMENTS", J.S. Zabinski, invited lecture, Ohio State University, Dept. of Mechanical Engineering, Columbus, OH, Jan 1993.

"EVALUATION OF PULSED LASER GROWN $MoS_2$, $WS_2$, AND $CF_x$ FILMS FOR USE WITH PERFLUOROPOLYALKYLETHER FLUIDS", J.S. Zabinski, A.E. Day, M.S. Donley, G. John, and N.T. McDevitt, Int. Conf. Met. Coatings and Thin Films, April, 1993, San Diego, CA.

"INITIAL METAL FLUORIDE FORMATION AT METAL/FLUOROCARBON INTERFACES", P.J. John and J. Liang, ACS Spring Meeting, April 1993, Denver CO.

"PULSED LASER DEPOSITION OF NIOBIUM DISELENIDE THIN FILMS", A.E. Day, S.D. Walck, and J.S. Zabinski, Presented at the Conference on Laser Ablation (COLA) - 1993, Oak ridge, TN, April, 1993.

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"ARBITRARY COMPOSITION PROFILES BY MBE USING DESORPTION MASS SPECTROMETRY", K.R. Evans, R. Kaspi, W.T. Cooley, C.R. Jones, and J. S. Solomon, Matl's. Res. Soc. Spring 1993 Meeting, San Fransisco, CA.

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"PULSED LASER DEPOSITION OF CARBON FILMS: DEPENDENCE OF FILM PROPERTIES ON LASER WAVELENGTH", P.T. Murray and D.T. Peeler, 122nd Annual TMS Meeting, Denver, CO. Invited 24 Feb 1993.

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